SWORD v17c Variable Reference

Quick-lookup for all variables in the v17c NetCDF export files (`{region}_sword_v17c.nc`).

Fill values: i4 = `-9999`, i8 = `-9999`, f8 = `-9999.0`. The reaches `edit_flag` variable declares a string `_FillValue` attribute of `"-9999.0"`, but reaches with no edit tag are stored as empty strings (`""`), not the literal `"-9999.0"`; other string variables have no fill value. In the `rch_id_up` / `rch_id_dn [4, N]` neighbor arrays, empty slots use `-9999` (v17b used `0`).

Distance Variable Conventions

SWORD contains four distance-to-outlet variables. They differ in routing method, zero-point, and reach endpoint reporting convention. The table below summarizes these conventions; see "Node-Level Interpolation" for how each extends to nodes.

Variable	Routing	Reach-level value	Outlet value	Ghost reaches
`dist_out` (v17b)	v17b topology	reported at reach upstream endpoint	`reach_length`	has value
`hydro_dist_out`	`rch_id_dn_main` chain	reported at reach upstream endpoint	`reach_length`	has value
`dist_out_dijkstra`	Dijkstra shortest path	reported at reach upstream endpoint	`reach_length`	has value
`hydro_dist_hw`	`rch_id_up_main` chain	reported at reach upstream endpoint	0	has value

Reach scalar convention. These reach-level values are endpoint reports, not traversal-origin claims. `dist_out`, `hydro_dist_out`, and `dist_out_dijkstra` are outlet-distance scalars reported at the upstream endpoint of each reach; each reach exceeds its downstream neighbor by its own `reach_length` on 1:1 links. `hydro_dist_hw` is also reported at the upstream endpoint, but measures distance from `best_headwater`; each downstream reach exceeds its upstream neighbor by the upstream neighbor's `reach_length` on 1:1 links.

Reference values. `dist_out`, `hydro_dist_out`, and `dist_out_dijkstra` all assign an outlet reach a value equal to its `reach_length` (the upstream endpoint is one reach length from the outlet point). `hydro_dist_hw` assigns 0 at the headwater.

Ghost reaches. All four distance variables retain values for ghost reaches in v17c, including `dist_out_dijkstra`.

Node-Level Interpolation

Six distance variables are interpolated per node using a midpoint offset within the parent reach: `offset = cumsum(node_length) - 0.5 * node_length`, where the cumulative sum is ordered by `node_order`. This places each node at the geometric center of its `node_length` segment. On a single-path network (no junctions), `dist_out`, `hydro_dist_out`, and `dist_out_dijkstra` are exactly equal at every node.

Variable	Node formula	node_order=n (upstream)	node_order=1 (downstream)
`dist_out`	`reach.do - reach_length + offset`	`~ reach.do`	`~ reach.do - reach_length`
`hydro_dist_out`	`reach.hdo - reach_length + offset`	`~ reach.hdo`	`~ reach.hdo - reach_length`
`dist_out_dijkstra`	`reach.dod - reach_length + offset`	`~ reach.dod`	`~ reach.dod - reach_length`
`hydro_dist_hw`	`reach.hdh + reach_length - offset`	`~ reach.hdh`	`~ reach.hdh + reach_length`

Variable	Node formula	node_order=n (upstream)	node_order=1 (downstream)
pathlen_hw	reach.plh - reach_length + offset	~ reach.plh - reach_length	~ reach.plh
pathlen_out	reach.plo + reach_length - offset	~ reach.plo + reach_length	~ reach.plo

Three additional variables (subnetwork_id, best_headwater, best_outlet) are flat copies from the parent reach.

Boundary behavior. The reach-level formulas imply continuous endpoint values on 1:1 links, but node values are midpoint samples within their node_length segments. Adjacent boundary nodes therefore need not be identical, and bifurcation-rejoin structures can retain larger single-scalar dist_out gaps.

New v17c Reach Variables

Variable	NetCDF Type	Units	Fill Value	Encoding	Description
dist_out_dijkstra	f8	meters	-9999.0		Dijkstra shortest-path outlet distance reported at the reach upstream endpoint; outlet reach = reach_length; values retained for ghost reaches
hydro_dist_out	f8	meters	-9999.0		Mainstem outlet distance reported at the reach upstream endpoint via rch_id_dn_main chain; outlet reach = reach_length
hydro_dist_hw	f8	meters	-9999.0		Mainstem headwater distance reported at the reach upstream endpoint via rch_id_up_main chain; headwater = 0
rch_id_up_main	i8		-9999		Main upstream neighbor reach ID (mainstem-preferred)
rch_id_dn_main	i8		-9999		Main downstream neighbor reach ID (mainstem-preferred)
subnetwork_id	i4		-9999		Connected component ID (Pfafstetter-offset, globally unique; differs from v17b network)
main_path_id	i8		-9999		ID of the mainstem path this reach belongs to

Variable	NetCDF Type	Units	Fill Value	Encoding	Description
is_mainstem	i4		-9999	0=not_mainstem; 1=mainstem	Whether reach is on a mainstem path
best_headwater	i8		-9999		Width-prioritized upstream headwater reach ID
best_outlet	i8		-9999		Width-prioritized downstream outlet reach ID
pathlen_hw	f8	meters	-9999.0		Cumulative reach_length sum from best_headwater to the downstream end of the reach (headwater = 0, increases downstream)
pathlen_out	f8	meters	-9999.0		Cumulative reach_length sum toward best_outlet (outlet = 0, increases upstream)
facc_quality	i4		-9999	1=denoise_v3	Flow accumulation correction flag
dl_grod_id	i8		-9999		DL-GROD (Deep Learning Global River Obstruction Database; He et al. 2025) dam/obstruction ID
wse_obs_p10	f8	meters	-9999.0		SWOT WSE 10th percentile
wse_obs_p20	f8	meters	-9999.0		SWOT WSE 20th percentile
wse_obs_p30	f8	meters	-9999.0		SWOT WSE 30th percentile
wse_obs_p40	f8	meters	-9999.0		SWOT WSE 40th percentile
wse_obs_p50	f8	meters	-9999.0		SWOT WSE 50th percentile (median)
wse_obs_p60	f8	meters	-9999.0		SWOT WSE 60th percentile
wse_obs_p70	f8	meters	-9999.0		SWOT WSE 70th percentile
wse_obs_p80	f8	meters	-9999.0		SWOT WSE 80th percentile
wse_obs_p90	f8	meters	-9999.0		SWOT WSE 90th percentile

Variable	NetCDF Type	Units	Fill Value	Encoding	Description
wse_obs_range	f8	meters	-9999.0		SWOT WSE range (p90 - p10)
wse_obs_mad	f8	meters	-9999.0		SWOT WSE median absolute deviation
width_obs_p10	f8	meters	-9999.0		SWOT width 10th percentile
width_obs_p20	f8	meters	-9999.0		SWOT width 20th percentile
width_obs_p30	f8	meters	-9999.0		SWOT width 30th percentile
width_obs_p40	f8	meters	-9999.0		SWOT width 40th percentile
width_obs_p50	f8	meters	-9999.0		SWOT width 50th percentile (median)
width_obs_p60	f8	meters	-9999.0		SWOT width 60th percentile
width_obs_p70	f8	meters	-9999.0		SWOT width 70th percentile
width_obs_p80	f8	meters	-9999.0		SWOT width 80th percentile
width_obs_p90	f8	meters	-9999.0		SWOT width 90th percentile
width_obs_range	f8	meters	-9999.0		SWOT width range (p90 - p10)
width_obs_mad	f8	meters	-9999.0		SWOT width median absolute deviation
slope_obs_p10	f8	meters/meters	-9999.0		SWOT slope 10th percentile
slope_obs_p20	f8	meters/meters	-9999.0		SWOT slope 20th percentile
slope_obs_p30	f8	meters/meters	-9999.0		SWOT slope 30th percentile
slope_obs_p40	f8	meters/meters	-9999.0		SWOT slope 40th percentile
slope_obs_p50	f8	meters/meters	-9999.0		SWOT slope 50th percentile (median)
slope_obs_p60	f8	meters/meters	-9999.0		SWOT slope 60th percentile
slope_obs_p70	f8	meters/meters	-9999.0		SWOT slope 70th percentile
slope_obs_p80	f8	meters/meters	-9999.0		SWOT slope 80th percentile
slope_obs_p90	f8	meters/meters	-9999.0		SWOT slope 90th percentile

Variable	NetCDF Type	Units	Fill Value	Encoding	Description
slope_obs_range	f8	meters/meters	-9999.0		SWOT slope range (p90 - p10)
slope_obs_mad	f8	meters/meters	-9999.0		SWOT slope median absolute deviation
slope_obs_adj	f8	meters/meters	-9999.0		Adjusted SWOT slope (bias-corrected)
slope_obs_slopeF	f8		-9999.0		Slope quality F-statistic
slope_obs_reliable	i4		-9999	0=unreliable; 1=reliable	Whether SWOT slope is reliable
slope_obs_quality	i4		-9999	0..8; see flag reference	SWOT slope quality category
slope_obs_n	i4		-9999		Number of RiverSP node observations used in pass-level slope fits
slope_obs_n_passes	i4		-9999		Number of SWOT passes with slope
slope_obs_q	i4		-9999	Integer bitfield (1=negative, 2=low_passes, 4=high_var, 8=extreme, 16=clipped)	SWOT slope quality bitfield
n_obs	i4		-9999		Total number of SWOT observations

New v17c Node Variables

Variable	NetCDF Type	Units	Fill Value	Encoding	Description
subnetwork_id	i4		-9999		Connected component ID (from parent reach)
best_headwater	i8		-9999		Width-prioritized upstream headwater reach ID
best_outlet	i8		-9999		Width-prioritized downstream outlet reach ID
pathlen_hw	f8	meters	-9999.0		Cumulative path length from headwater, interpolated by node position within reach; single-node reaches use midpoint

Variable	NetCDF Type	Units	Fill Value	Encoding	Description
pathlen_out	f8	meters	-9999.0		Cumulative path length to outlet, interpolated by node position within reach; single-node reaches use midpoint
hydro_dist_out	f8	meters	-9999.0		Mainstem distance to best_outlet, interpolated by node position within reach; single-node reaches use midpoint
hydro_dist_hw	f8	meters	-9999.0		Distance from best_headwater, interpolated by node position within reach; single-node reaches use midpoint
dist_out_dijkstra	f8	meters	-9999.0		Dijkstra shortest-path distance to outlet, interpolated by node position within reach; single-node reaches use midpoint; values retained for ghost reaches
wse_obs_p10	f8	meters	-9999.0		SWOT WSE 10th percentile
wse_obs_p20	f8	meters	-9999.0		SWOT WSE 20th percentile
wse_obs_p30	f8	meters	-9999.0		SWOT WSE 30th percentile
wse_obs_p40	f8	meters	-9999.0		SWOT WSE 40th percentile
wse_obs_p50	f8	meters	-9999.0		SWOT WSE 50th percentile (median)
wse_obs_p60	f8	meters	-9999.0		SWOT WSE 60th percentile
wse_obs_p70	f8	meters	-9999.0		SWOT WSE 70th percentile
wse_obs_p80	f8	meters	-9999.0		SWOT WSE 80th percentile
wse_obs_p90	f8	meters	-9999.0		SWOT WSE 90th percentile
wse_obs_range	f8	meters	-9999.0		SWOT WSE range (p90 - p10)

Variable	NetCDF Type	Units	Fill Value	Encoding	Description
wse_obs_mad	f8	meters	-9999.0		SWOT WSE median absolute deviation
width_obs_p10	f8	meters	-9999.0		SWOT width 10th percentile
width_obs_p20	f8	meters	-9999.0		SWOT width 20th percentile
width_obs_p30	f8	meters	-9999.0		SWOT width 30th percentile
width_obs_p40	f8	meters	-9999.0		SWOT width 40th percentile
width_obs_p50	f8	meters	-9999.0		SWOT width 50th percentile (median)
width_obs_p60	f8	meters	-9999.0		SWOT width 60th percentile
width_obs_p70	f8	meters	-9999.0		SWOT width 70th percentile
width_obs_p80	f8	meters	-9999.0		SWOT width 80th percentile
width_obs_p90	f8	meters	-9999.0		SWOT width 90th percentile
width_obs_range	f8	meters	-9999.0		SWOT width range (p90 - p10)
width_obs_mad	f8	meters	-9999.0		SWOT width median absolute deviation
n_obs	i4		-9999		Total number of SWOT observations
facc_quality	i4		-9999	1=denoise_v3	Flow accumulation correction flag

v17b Variables

Values are unchanged from v17b unless noted elsewhere in the release notes. Rows marked "Not in v17b NetCDF; added in v17c" are database attributes that v17c now includes in the NetCDF export; they were not variables in the v17b NetCDF files.

`edit_flag` note. `edit_flag` is a comma-delimited tag list recording edit provenance. Values include v17b numeric edit codes (e.g. `1`, `7`), the literal string `NaN` (v17b's no-edit placeholder — present on ~126K reaches; parsers must treat it as a string, not a float), and v17c tags: `facc_denoise_v3`, `harp_lake`, `lake_sandwich`, `clf_reconcile`, `clf_provisional_river`, `ghost_reclass`, `facc_suspect`, `facc_traced`. Multiple tags combine comma-delimited (e.g. `harp_lake,clf_reconcile`). In the NetCDF export, the reaches `edit_flag` variable declares a string `_FillValue` attribute of `"-9999.0"`, but reaches with no edit tag are stored as empty strings (`""`), not the literal `"-9999.0"`. Treat an empty string (and the `NaN` placeholder) as "no edit."

Reaches

Variable	NetCDF Type	Units	Fill Value	Description
reach_id	i8		-9999	Reach identifier (format: CBBBBBRRRRT)
x	f8	degrees east	-9999.0	Reach centroid longitude
x_min	f8	degrees east	-9999.0	Minimum longitude of reach extent
x_max	f8	degrees east	-9999.0	Maximum longitude of reach extent
y	f8	degrees north	-9999.0	Reach centroid latitude
y_min	f8	degrees north	-9999.0	Minimum latitude of reach extent
y_max	f8	degrees north	-9999.0	Maximum latitude of reach extent
reach_length	f8	meters	-9999.0	Length of reach centerline
n_nodes	i4		-9999	Number of nodes in reach
wse	f8	meters	-9999.0	Water surface elevation (MERIT Hydro)
wse_var	f8	meters^2	-9999.0	WSE variance
width	f8	meters	-9999.0	River width (GRWL)
width_var	f8	meters^2	-9999.0	Width variance
facc	f8	km^2	-9999.0	Flow accumulation (MERIT Hydro)
n_chan_max	i4		-9999	Max number of channels at any node
n_chan_mod	i4		-9999	Modal number of channels
obstr_type	i4		-9999	Obstruction type (0=none, 1=dam, 2=lock, 3=low-head, 4=falls)
grod_id	i8		-9999	GRanD/GROD dam ID
hfalls_id	i8		-9999	High falls ID
slope	f8	meters/kilometers	-9999.0	Water surface slope from MERIT DEM
dist_out	f8	meters	-9999.0	Network outlet distance reported at the reach upstream endpoint (v17b original; outlet reach = reach_length, not 0). See "Distance Variable Conventions" for comparison with v17c distance variables
n_rch_up	i4		-9999	Number of upstream neighbor reaches
n_rch_down	i4		-9999	Number of downstream neighbor reaches
lakeflag	i4		-9999	Water body type (0=river, 1=lake, 2=canal, 3=tidal)

Variable	NetCDF Type	Units	Fill Value	Description
type	i4		-9999	Reach type (1=river, 3=lake_on_river, 4=dam, 5=unreliable, 6=ghost). Not in v17b NetCDF; added in v17c. Values from v17b database.
add_flag	string			Manually added reach flag. Not in v17b NetCDF; added in v17c.
swot_obs	i4		-9999	Number of expected SWOT observations per cycle
swot_obs_source	string			Source of SWOT observation data. Not in v17b NetCDF; added in v17c.
max_width	f8	meters	-9999.0	Maximum width at any node
low_slope_flag	i4		-9999	Low slope flag
trib_flag	i4		-9999	MHV tributary enters (0=no, 1=yes, spatial proximity)
path_freq	i8		-9999	Traversal count (increases toward outlets)
path_order	i8		-9999	Path order from traversal
path_segs	i8		-9999	Unique ID for (path_order, path_freq) combination
stream_order	i4		-9999	Stream order: round(log(path_freq)) + 1
main_side	i4		-9999	Channel role (0=main, 1=side, 2=secondary outlet)
end_reach	i4		-9999	Endpoint type (0=middle, 1=headwater, 2=outlet, 3=junction)
network	i4		-9999	Connected component ID
dn_node_id	i8		-9999	Downstream boundary node ID. Not in v17b NetCDF; added in v17c.
up_node_id	i8		-9999	Upstream boundary node ID. Not in v17b NetCDF; added in v17c.
river_name	string			River name from GRWL
river_name_en	string			River name (English). Not in v17b NetCDF; added in v17c.
river_name_local	string			River name (local language). Not in v17b NetCDF; added in v17c.

Variable	NetCDF Type	Units	Fill Value	Description
edit_flag	string			Comma-delimited edit provenance tags; see the `edit_flag` note below
version	string			Data version identifier. Not in v17b NetCDF; added in v17c.

Nodes

Variable	NetCDF Type	Units	Fill Value	Description
node_id	i8		-9999	Node identifier (format: CBBBBBRRRRNNNT)
x	f8	degrees east	-9999.0	Node longitude
y	f8	degrees north	-9999.0	Node latitude
node_length	f8	meters	-9999.0	Length of river represented by this node
node_order	i4		-9999	1-based position within reach (1=downstream, n=upstream, by dist_out). Not in v17b NetCDF; added in v17c.
reach_id	i8		-9999	Parent reach ID (format: CBBBBBRRRRT)
wse	f8	meters	-9999.0	Water surface elevation (MERIT Hydro)
wse_var	f8	meters^2	-9999.0	WSE variance
width	f8	meters	-9999.0	River width (GRWL)
width_var	f8	meters^2	-9999.0	Width variance
n_chan_max	i4		-9999	Max number of channels
n_chan_mod	i4		-9999	Modal number of channels
obstr_type	i4		-9999	Obstruction type
grod_id	i8		-9999	GRanD/GROD dam ID
hfalls_id	i8		-9999	High falls ID
dist_out	f8	meters	-9999.0	Distance to network outlet. Interpolated from reach `dist_out` using node_length midpoint offsets (same formula as `hydro_dist_out` and `dist_out_dijkstra`). On single-path networks all three are exactly equal
wth_coef	f8		-9999.0	Width coefficient
ext_dist_coef	f8		-9999.0	Extraction distance coefficient
facc	f8	km^2	-9999.0	Flow accumulation (MERIT Hydro)

Variable	NetCDF Type	Units	Fill Value	Description
lakeflag	i8		-9999	Water body type (0=river, 1=lake, 2=canal, 3=tidal). Propagated from parent reach lakeflag per JPL request.
max_width	f8	meters	-9999.0	Maximum width
meander_length	f8		-9999.0	Meander wavelength
sinuosity	f8		-9999.0	Channel sinuosity
manual_add	i4		-9999	Manually added node flag
trib_flag	i4		-9999	MHV tributary enters (0=no, 1=yes)
path_freq	i8		-9999	Traversal count
path_order	i8		-9999	Path order
path_segs	i8		-9999	Path segment ID
stream_order	i4		-9999	Stream order
main_side	i4		-9999	Channel role (0=main, 1=side, 2=secondary outlet)
end_reach	i4		-9999	Endpoint type (0=middle, 1=headwater, 2=outlet, 3=junction)
network	i4		-9999	Connected component ID
add_flag	string			Manually added node flag. Not in v17b NetCDF; added in v17c.
river_name	string			River name
edit_flag	string			Comma-delimited edit provenance tags; see the `edit_flag` note below
version	string			Data version identifier. Not in v17b NetCDF; added in v17c.

Multi-dimensional Arrays

Variable	Group	Shape	Type	Description
cl_ids	reaches	[2, num_reaches]	i8	Min (row 0) and max (row 1) centerline point IDs bounding each reach (v17b format)
rch_id_up	reaches	[4, num_reaches]	i8	Up to 4 upstream neighbor reach IDs
rch_id_dn	reaches	[4, num_reaches]	i8	Up to 4 downstream neighbor reach IDs
iceflag	reaches	[366, num_reaches]	i4	Daily ice presence flag (Julian day 1-366)

Variable	Group	Shape	Type	Description
swot_orbits	reaches	[75, num_reaches]	i8	SWOT orbit IDs that observe this reach
cl_ids	nodes	[2, num_nodes]	i8	Min (row 0) and max (row 1) centerline point IDs bounding each node (v17b format)
cl_id	centerlines	[num_points]	i8	Centerline point ID
x	centerlines	[num_points]	f8	Centerline point longitude (degrees east)
y	centerlines	[num_points]	f8	Centerline point latitude (degrees north)
reach_id	centerlines	[4, num_points]	i8	Reach ID at each centerline point (row 0); rows 1-3 hold neighboring reach IDs at reach boundaries. Copied from v17b
node_id	centerlines	[4, num_points]	i8	Node ID at each centerline point (row 0); rows 1-3 hold neighboring node IDs. Copied from v17b

Subgroups (copied from v17b)

Subgroup	Parent	Description
reaches/area_fits	reaches	Area-based rating curve fit coefficients
reaches/discharge_models	reaches	Discharge model parameters (organized by constraint/model)